

Oxychlorine species in Gale Crater and broader implications for Mars

P. Douglas Archer, Jr., Jacobs, NASA Johnson Space Center
Joanna C. Hogancamp, JETS, NASA JSC
Douglas W. Ming, JSC
Brad Sutter, Jacobs, JSC
Richard V. Morris, JSC
B.C. Clark, Space Science Institute, Boulder, CO
P.H. Mahaffy, GSFC
C. Achilles, Department of Geosciences, University of Arizona
J.J. Wray, Georgia Institute of Technology
A.G. Fairen, Centro de Astrobiología (INTA-CSIC), Madrid, Spain
Ralf Gellert, ⁷University of Guelph, ON, Canada
Albert Yen, JPL
David F. Blake, ARC
David T. Vaniman, PSI
Daniel P. Glavin, GSFC
Jen Eigenbrode, GSFC
M.G. Trainer, GSFC
Rafael Navarro-González, UNAM
Christopher P. McKay, ARC
Caroline Freissinet, GSFC
Peter Martin, Caltech

Of 15 samples analyzed to date, the Sample Analysis at Mars (SAM) instrument on the Mars Science Laboratory (MSL) has detected oxychlorine compounds (perchlorate or chlorate) in 12 samples. The presence of oxychlorine species is inferred from the release of oxygen at temperatures <600 °C and HCl between 350-850 °C when a sample is heated to 850 °C. The O₂ release temperature varies with sample, likely caused by different cations, grain size differences, or catalytic effects of other minerals. In the oxychlorine-containing samples, perchlorate abundances range from 0.06 ± 0.03 to 1.15 ± 0.5 wt% Cl₂O₇ equivalent. Comparing these results to the elemental Cl concentration measured by the Alpha Particle X-ray Spectrometer (APXS) instrument, oxychlorine species account for 5-40% of the total Cl present.

The variation in oxychlorine abundance has implications for their production and preservation over time. For example, the John Klein (JK) and Cumberland (CB) samples were acquired within a few meters of each other and CB contained ~1.2 wt% Cl₂O₇ equivalent while JK had ~0.1 wt%. One difference between the two samples is that JK has a large number of veins visible in the drill hole wall, indicating more post-deposition alteration and removal.

Finally, despite Cl concentrations similar to previous samples, the last three Murray formation samples (Oudam, Marimba, and Quela) had no detectable oxygen released during pyrolysis. This could be a result of oxygen reacting with other species in the sample during pyrolysis. Lab work has shown this is likely to have occurred in SAM but it is unlikely to have consumed all the O₂ released. Another explanation is that the Cl is present as chlorides, which is consistent with data from the ChemCam (Chemical Camera) and CheMin (Chemistry and Mineralogy) instruments on MSL. For example, the Quela sample has ~1 wt% elemental Cl detected by APXS, had no detectable O₂ released, and halite (NaCl) has been tentatively identified in CheMin X-ray diffraction data.

These data show that oxychlorines are likely globally distributed on Mars but the distribution is heterogenous depending on the perchlorate formation mechanism (production rate), burial, and subsequent diagenesis.